1.

**(c)** Water bears are extremely common in many habitats, including household gardens. However, they were not discovered until approximately 300 years ago.

Suggest reasons why they were not known before this time.

.....

.....

.....

.....

..... **[2]**

**[Total: 10]**

Fig. 8.1, **on the insert**, shows an electron micrograph of an invertebrate known as a 'water bear'.

**(a)** Complete the following passage about the classification of water bears using the most appropriate terms.

The water bear, *Echiniscus trisetosus* is a member of the genus ..... and the family *Echiniscidae*. This family belongs to the ..... *Echiniscoidea*, which forms part of the class *Heterotardigrada*. Water bears, also known as tardigrades, are classified into a ..... of their own called the *Tardigrada*. Tardigrades form part of the kingdom ..... within the domain ..... . **[5]**

**(b)** State the meaning of the term *phylogeny* **and** explain how phylogeny is related to classification.

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..... **[3]**

**2.**

Living organisms can be classified into five kingdoms, based on certain key characteristics.

**(a)** Table 2.1 shows some of the characteristics of the five kingdoms.

Complete the table.

**Table 2.1**

| kingdom | membrane-bound organelles | cell wall | type(s) of nutrition |
|---|---|---|---|
| prokaryote | absent | present – made of peptidoglycan | |
| | present | sometimes present – composition varies | heterotrophic and autotrophic |
| fungi | | present – made of chitin | heterotrophic |
| | present | | autotrophic |
| animal | | absent | heterotrophic |

**[6]**

**(b)** An unknown species is discovered. Its cells contain many nuclei scattered throughout the cytoplasm of thread-like structures.

Suggest the kingdom to which this species belongs.

..... **[1]**

**3.**

Bats are the only mammals that can truly fly. Many species of bat hunt flying insects at night. Bats are able to use sound waves (echolocation) in order to help them find their prey in the dark.

**(a)** Suggest how the ability to use echolocation may have evolved from an ancestor that did not have that ability.

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..... **[4]**

The pipistrelle is the most common species of bat in Europe. It was originally thought that all pipistrelles belonged to the same species, *Pipistrellus pipistrellus*. However, in the 1990s, it was decided that there were two species: the common pipistrelle, *Pipistrellus pipistrellus* and the soprano pipistrelle, *Pipistrellus pygmaeus*.

Data for both species are provided in Table 3.1.

**Table 3.1**

| species | mean body mass (g) | mean wingspan (m) | range of echolocation call (kHz) | colour |
|---|---|---|---|---|
| common pipistrelle | 5.5 | 0.22 | 42–47 | medium to dark brown |
| soprano pipistrelle | 5.5 | 0.21 | 52–60 | medium to dark brown |

**(b)** **(i)** Name the genus to which the soprano pipistrelle belongs.

..... **[1]**

**(ii)** Using the data in Table 3.1, suggest why pipistrelles were originally classified as one species.

.....

.....

..... **[1]**

**(iii)** State **two** pieces of **molecular** evidence that can be used to identify organisms as belonging to different species.

.....

..... **[2]**

**(iv)** Describe how it is possible to confirm, over a longer period of time, whether two organisms belong to different species or the same species.

.....

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.....

..... **[2]**

**4.**

DNA and RNA are nucleic acids.

**(a)** The table below contains a number of statements relating to nucleic acids.

Complete the table, using a letter **D**, **R** or **B**, to show whether each statement applies to:

- DNA only (**D**)
- RNA only (**R**)
- both DNA and RNA (**B**).

The first one has been done for you.

| statement | DNA only (**D**)<br>or<br>RNA only (**R**)<br>or<br>both DNA and RNA (**B**) |
|---|---|
| contains thymine | D |
| contains ribose | |
| consists of two chains connected to each other with hydrogen bonds | |
| has a sugar-phosphate backbone | |
| has four different nitrogenous bases | |
| contains a pentose sugar | |
| is found in the nucleus and cytoplasm | |

**[6]**

**(b)** It has been found that 98.4% of chimpanzee DNA is identical to that of a human.

**(i)** Suggest how the information obtained by DNA analysis can be useful to taxonomists.

.....

.....

.....

..... **[2]**

**(ii)** State **two** types of evidence, other than biochemical evidence, that are used by taxonomists when classifying organisms.

.....

.....

.....

..... **[2]**

**(c)** Cytochrome C is a protein found in living organisms. The structure of cytochrome C varies between different organisms. However, closely related organisms have similar cytochrome C.

Fig. 5.1 shows a possible evolutionary tree for vertebrates.
Common ancestors are indicated by the number 1 and various letters.

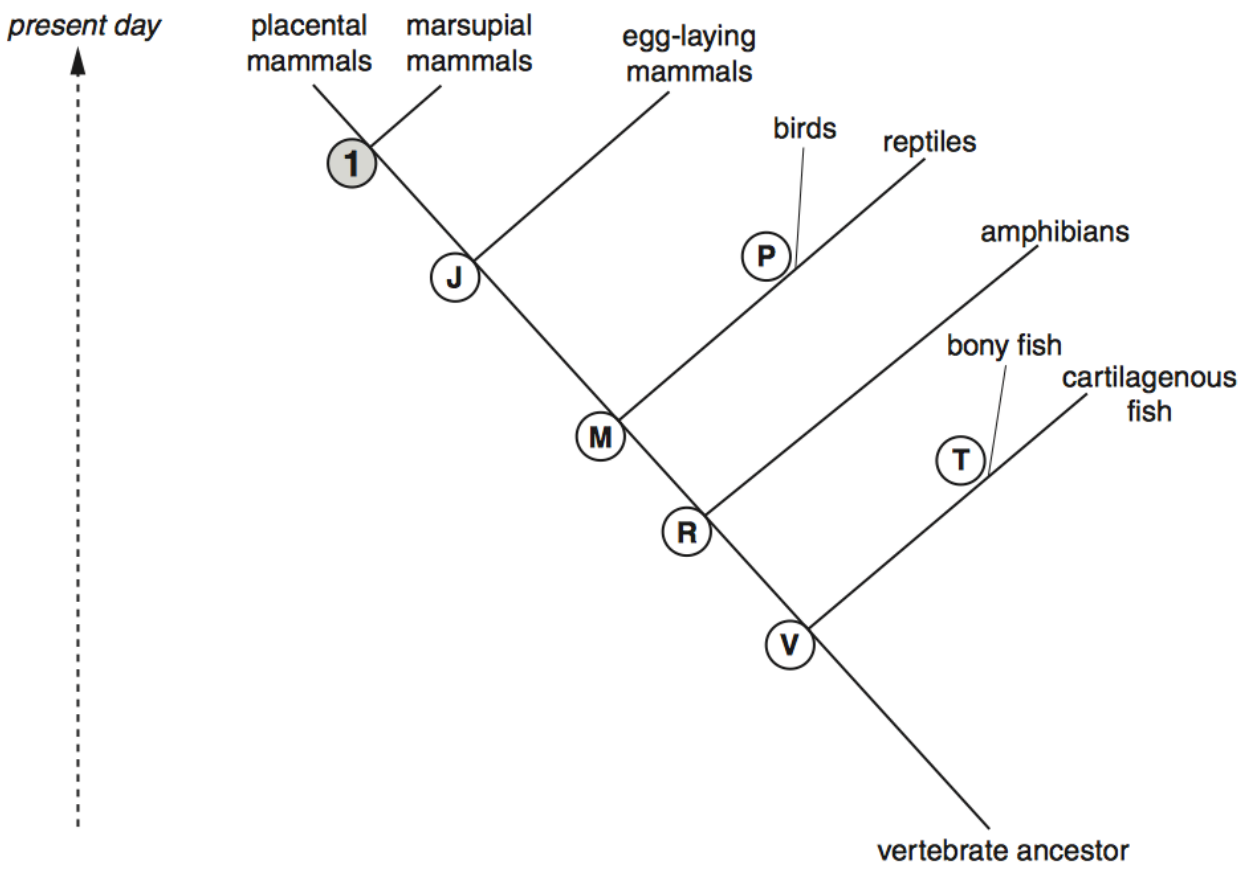


**Fig. 5.1**

State the **letter** of the common ancestor that has cytochrome C which will be:

**most** similar in structure to common ancestor **1** .....

**least** similar in structure to common ancestor **1** ..... **[2]**

**(d)** The pine marten is a small mammal that is rare in the United Kingdom. Its numbers are particularly low in Wales and there have been few confirmed sightings of this animal in the past 50 years. There have been plans to introduce pine martens from other areas of the United Kingdom into Wales to increase the size of the population.

The DNA of museum specimens of Welsh pine martens in the National Museum of Wales was tested, the most recent specimens dating from 1948. The DNA analysis suggests that Welsh pine martens are genetically distinct from those found elsewhere in the United Kingdom.

**(i)** The relevance of this analysis has been questioned by some scientists.

Suggest why the findings from the museum specimens may not relate closely to the current pine marten population of the United Kingdom.

.....

.....

..... **[1]**

**(ii)** Suggest why some people are concerned about the plan to introduce pine martens from other areas into Wales.

.....

.....

..... **[1]**

**[Total: 14]**

**5.**

When a new species is discovered, it needs to be classified.

**(a)** Define the term *classification.*

.....

.....

.....

.....

..... **[2]**

**(b)** **(i)** Suggest what criteria a taxonomist may take into account when classifying a new species.

.....

.....

.....

.....

.....

.....

.....

..... **[3]**

**(ii)** Table 2.1 shows the main taxonomic groups. The groups are **not** in the correct order.

**Table 2.1**

| | Q | R | S | T | U | V | W |
|---|---|---|---|---|---|---|---|
| taxonomic group | species | order | class | phylum | genus | kingdom | family |

Place the **letters** representing the taxonomic groups into the correct order.

The first one has been done for you.

**V** ..... ..... ..... ..... ..... ..... ..... **[3]**

**Answers**

**1.**

| Question | | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|---|
| 8 | (a) | | | | 5 | **Mark the first answer on each prompt line.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**<br>**ACCEPT** phonetic spellings |
| | | | 1 | *Echiniscus* ; | | **1** Initial letter must be upper case |
| | | | 2 | order ; | | **2 ACCEPT** super family / epifamily |
| | | | 3 | phylum ; | | |
| | | | 4 | Animalia ; | | **4 ACCEPT** animals<br>**4 IGNORE** case of initial letter |
| | | | 5 | Eukaryota ; | | **5 ACCEPT** eukaryotes / Eukarya / eukaryotic<br>**5 IGNORE** case of initial letter |
| 8 | (b) | | 1 | (phylogeny is) evolutionary relationships (between organisms) ; | 3 | **1 IGNORE** 'evolution' without further qualification<br>**1&2** phylogeny is the closeness of evolutionary relationships = 2 **marks**<br>**1 ACCEPT** phylogeny is evolutionary history |
| | | | 2 | (phylogeny is study of) closeness of (evolutionary) relationships ; | | |
| | | | 3 | phylogeny is basis of / used in , natural / scientific / modern, classification ; | | **3 ACCEPT** new<br>**3 IGNORE** related to classification |
| | | | 4 | *idea that* the closer the (evolutionary or genetic) relationship the closer the (taxonomic) grouping ; | | **4 ACCEPT** ref to **recent** common ancestors as AW for close relationship<br>**4 ACCEPT** named taxonomic group for 'grouping'<br>**4 ACCEPT** 'if the DNA is very different then the group is not the same' |
| | | | 5 | correct use of example ; | | **5** e.g. gorillas and chimpanzees (closely grouped) |

| Question | | | Answer | Marks | Guidance |
|---|---|---|---|---|---|
| 8 | (c) | | too small to see ; | 2 | 'can only be seen under microscope' **= 1 mark (mp1)**<br>**IGNORE** 'can't see it' without the idea of size, e.g.<br>can't see it clearly = **0 marks**,<br>can't see its features = **0 marks**<br>**ACCEPT** implication of being too small to see, e.g.<br>'you need a microscope to see them' **= mp1**<br>'people couldn't see them in the past because we didn't have microscopes' **= 2marks (mp1 and mp2)** |
| | | | (unable to see them) until invention of microscope / development of suitable viewing apparatus / AW ; | | **IGNORE** type of microscope if stated<br>**ACCEPT** 'magnifying glass' |
| | | | only 0.3mm in length ; | | **ACCEPT** ± 0.1 mm |
| | | | **Total** | **10** | |

**2.**

| | | | | |
|---|---|---|---|---|
| (a) | | | 6 | **Mark the first answer in each box.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks** |

| kingdom | membrane -bound organelles | cell wall | type(s) of nutrition |
|---|---|---|---|
| | | | heterotrophic **and** autotrophic ; |
| protoctist(s)/ *Protoctista* ; | | | |
| | present ; | | |
| plant(s) / *Plantae* ; | | (present and made of) cellulose ; | |
| | present ; | | |

**IGNORE** case of initial 'P'

**ACCEPT** '✓' or 'yes'

**IGNORE** case of initial 'P'

**ACCEPT** '✓' or 'yes'

| | | | | |
|---|---|---|---|---|
| (b) | | fungi ; | 1 | **Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**<br><br>**ALLOW** fungus / fungal / fungae<br>**IGNORE** case of initial 'f' |

**3.**

| | | | | | |
|---|---|---|---|---|---|
| (a) | | **1** | natural / directional , selection ; | **4 max** | |
| | | **2** | mutation ; | | **2 DO NOT CREDIT** if implied as a consequence of selection pressure |
| | | **3** | (mutation / genetic variation, is) random / due to chance / spontaneous / pre-existing ; | | |
| | | **4** | selection pressure is lack of / competition for , food / prey ; | | **4 ACCEPT** 'selection pressure is ability to hunt'<br>**4 ACCEPT** 'selective pressure' |
| | | **5** | individuals with mutation(s) / allele(s) / gene(s) (for echolocation) , survive **; ora** | | **5 IGNORE** refs to breeding / reproduction<br>**5 ACCEPT** 'individuals that can echolocate survive' **ora**<br>**5 DO NOT CREDIT** if answer implies that echolocation is a learned behaviour |
| | | **6** | (echolocation) allele(s) / gene(s) / mutation(s) , passed on ( to next generation) ; | | **6 IGNORE** 'genetic trait(s)' |
| | | **7** | over many generations frequency of , echolocation / allele / characteristic , increases ; | | **7** Answers must imply multiple generations<br>**7 ACCEPT** 'over time' as an alternative to 'over many generations' but must be further qualified |
| (b) | (i) | | *Pipistrellus* ; | 1 | **Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**<br><br>**IGNORE** case of initial letter 'P'<br>**DO NOT CREDIT** if species name given as well |

| | | | | |
|---|---|---|---|---|
| (b) | (ii) | similar / same, (body) mass ;<br><br>similar wingspan ;<br><br>`similar / same, colour ;<br><br>all characteristics , similar / same, except echolocation / wingspan ;<br><br>previously unable to measure echolocation (frequency) ; | 1 max | **Mark the first answer.** If the answer is correct and an additional answer is given that is incorrect or contradicts the correct answer then = **0 marks**<br><br>**IGNORE** 'similar appearance'<br>**ACCEPT** 'both 5.5 g'<br><br>**IGNORE** 'same'<br>**ACCEPT** 'almost the same' or 'small difference' or ref to figures<br><br>**ACCEPT** 'both (medium to dark) brown' |
| (b) | (iii) | **1** genetics / genes / DNA ;<br><br>**2** RNA ;<br><br>**3** amino acid sequences ;<br><br>**4** cytochrome C / fibrinopeptide ; | 2 max | **Mark the first two answers only.**<br><br>**1 IGNORE** chromosomes<br>**1 ACCEPT** (named) bases<br>**1 or 2 CREDIT** 'nucleotide sequence / polynucleotide base sequence' for 1 mark if neither of mp 1 nor mp 2 have been awarded<br><br>**3 ACCEPT** primary structure of polypeptide<br><br>**4 ACCEPT** haemoglobin |

| | | | | |
|---|---|---|---|---|
| (b) | **(iv)** | (inter)breed / AW ;<br><br>determine if offspring are fertile ;<br><br>if offspring are infertile / no offspring produced, then different species ; **ora** | 2 max | **ACCEPT** 'mate' / 'reproduce'<br>**CREDIT** 'observe to see if populations are reproductively isolated' as resitting A2 candidate might consider phylogenetic species definition<br><br>This mark is for assessing the fertility of the offspring<br><br>'if they belong to the same species they will be able to breed with each other and produce fertile offspring' = 2 marks (1st and 3rd) |

**4.**

**(a)**

| statement | DNA only (**D**) or RNA only (**R**) or both DNA and RNA (**B**) | |
|---|---|---|
| contains thymine | **D** | |
| contains ribose | **R** | ; |
| consists of 2 chains connected to each other with hydrogen bonds | **D** | ; |
| has a sugar-phosphate backbone | **B** | ; |
| has 4 different nitrogenous bases | **B** | ; |
| contains a pentose sugar | **B** | ; |
| is found in the nucleus and cytoplasm | **R** | ; |

**6**

**Award** 1 mark for each correct row
**DO NOT CREDIT** if more than one letter in a box

| | | | | |
|---|---|---|---|---|
| **(b)** | **(i)** | | | |
| | **1** | (information used to) decide which, group / taxon, organism / species / named example, fits in ; | | **1** answers must refer to the information provided by the study of DNA, rather than simply the job of taxonomists, e.g. **ACCEPT** 'it can be used to put organisms into groups'<br>**1 IGNORE** 'for classification' unqualified – look for idea of: groups<br>**1 CREDIT** ref to belonging to same taxonomic group, e.g. 'to see if it belongs in the genus *Homo*' |
| | **2** | compare the proportion of (different) bases ; | | **2 IGNORE** 'examine proportion of bases'<br>**2 CREDIT** idea for looking at similarities / differences |
| | **3** | compare the DNA / genes / sequence of bases ; | | **3 IGNORE** 'examine sequence of bases'<br>**3 CREDIT** idea for looking at similarities / differences |
| | **4** | *idea of:* the more similar the, DNA / genes, the closer the relationship / AW ; | **2 max** | **4** Must contain reference to similarity of DNA |
| **(b)** | **(ii)** | | | **Mark the first <u>two</u> suggestions**<br>**IGNORE** ref to genetics as DNA is 'biochemical' |
| | **1** | fossil record ; | | |
| | **2** | anatomy / physiology / behaviour ; | | **2 ACCEPT** AW for anatomy, e.g. observable / physical features / cell structure<br>**2 ACCEPT** AW for physiology, e.g. method of reproduction |
| | **3** | embryology / AW ; | **2 max** | |
| **(c)** | | **J** ;<br>**T** ; | **2** | **DO NOT CREDIT** names |
| **(d)** | **(i)** | | | |
| | **1** | no DNA from living specimens in Wales analysed ; | | |
| | **2** | population (may have) evolved / mutations have occurred / genetic variation, (since 1948) ; | **1 max** | **2 ACCEPT** description of evolved<br>**2 DO NOT CREDIT** 'evolution' unqualified by context of pine marten population |
| **(d)** | **(ii)** | | | **ACCEPT** animals as AW for pine martens throughout answer |
| | **1** | (introduced) pine martens might not be adapted to local conditions / AW ; | | **1 ACCEPT** not adapted to the habitat<br>**1 DO NOT CREDIT** 'used to' |
| | **2** | (local) habitat, might have changed / is no longer suitable (for any pine martens) / AW ; | | |
| | **3** | introduced, pine martens, might outcompete native, population / pine martens ; | | **3 ACCEPT** introduced pine martens might kill native / Welsh pine martens<br>**3 IGNORE** 'compete' unqualified |
| | **4** | introduced pine martens might bring disease ; | | |
| | **5** | Welsh pine marten would lose its, distinctiveness / identity, because of interbreeding ; | **1 max** | |
| | | **Total** | **14** | |

**5.**

| | | | | |
|---|---|---|---|---|
| **(a)** | | placing, living things / organisms / named organisms, into, groups / categories / taxa / named taxonomic groups ;<br>based on / AW, similarity / difference ; | **2** | **ACCEPT** 'grouping living things'<br><br>Look for the idea of similar organisms being placed in the same group or different organisms being placed in different groups |
| **(b)** | **(i)** | | | **ACCEPT suitable examples for mps 1 to 4** |
| | **1** | morphology / anatomy / (observable / physical) features / appearance / AW ; | | ***1*** **CREDIT** cell features e.g. nucleus / membrane-bound organelles / cell wall / prokaryotic-eukaryotic features / unicellular |
| | **2** | biochemistry / cytochrome C ; | | ***2*** **CREDIT** component of cell wall |
| | **3** | genes / DNA / genetics / RNA ; | | ***3*** **IGNORE** chromosomes |
| | **4** | behaviour / physiology / embryology ; | | ***4*** **ACCEPT** 'how they feed' / nutrition / 'how they reproduce' |
| | **5** | idea of shared, evolutionary past / phylogeny ; | **3 max** | ***5*** **ACCEPT** 'how closely related'<br>**IGNORE** refs to interbreeding / fertile offspring |
| **(b)** | **(ii)** | T S R W U Q ; ; ; | **3** | **Mark the order of letters** (ignoring the dotted lines)<br>All 6 in correct order = 3 marks<br>If any incorrect, then credit<br>T S in order at beginning = 1 mark<br>U Q in order at end = 1 mark<br>R before W anywhere in the sequence = 1 mark |